

Fight fire! Fill up with foam

Carbon dioxide is widely used in fire extinguishers. Because carbon dioxide is heavier than air it smothers and extinguishes fires by preventing further oxygen from reaching the source of the flames.

However, one of the difficulties in putting out big oil fires in the open air is that the wind blows away the carbon dioxide gas, allowing oxygen to reach the fire, keeping it burning. Ideally, we should apply the carbon dioxide not as a gas but as a blanket of thick foam.

- Your task

Make as much foam as possible (measured in a very large container) using:

1 Any combination of the 3 liquids (you are allowed a maximum volume of 20 cm³ of each).

2 Any combination of the 3 solids (in this case you are allowed a maximum of 6 spatula fulls of each).

These can be mixed in any order, but must not be shaken or stirred.

Based on a suggestion by I.M. Childs/M. Goodall.

Time

70 minutes.

Group size

2–3.

Equipment & materials

Eye protection.

General

Large measuring cylinders (500, 1000 cm³) or empty 1 litre plastic lemonade bottles with tops cut off, pestles and mortars, spatulas. Sodium hydrogencarbonate, sulfuric acid (2 mol dm⁻³), aluminium sulfate, washing up liquid, washing powder, water, food colouring—optional (see possible approaches below).

Safety notes

This is an open-ended problem solving activity, so the guidance given here is necessarily incomplete. Teachers need to be particularly vigilant, and a higher degree of supervision is needed than in activities which have more closed outcomes. Students must be encouraged to take a responsible attitude towards safety, both their own and that of others. In planning an activity students should always include safety as a factor to be considered. Plans should be checked by the teacher before implementing them.

You must always comply with your employer's procedures and in some cases may decide that a particular activity is inappropriate in your situation. Further information on Health and Safety should be obtained from reputable sources such as CLEAPSS [<http://science.cleapss.org.uk/>] in England, Wales and Northern Ireland and, in Scotland, SSERC [<https://www.sserc.org.uk/>].

Sulfuric acid, 2 M H₂SO₄ (aq), is CORROSIVE. Wear safety goggles.

Aluminium Sulfate causes eye damage at solutions of over 3% and is an irritant over 1%.

Disposal: Any remaining acid should be neutralised with weak alkali before being washed to waste.

It is the responsibility of the teacher to carry out a suitable risk assessment.

Curriculum links

Colloids. Combustion and Firefighting. Carbon dioxide.

Possible approaches

A foam is a colloidal system in which a gas is dispersed in a liquid. Construction of a table to record results would be useful and aid systematic working. The foam is formed when a sodium hydrogencarbonate solution is mixed with a solution containing a detergent and aluminium sulfate (or any weak acid). Carbon dioxide gas is produced which is trapped by the detergent.

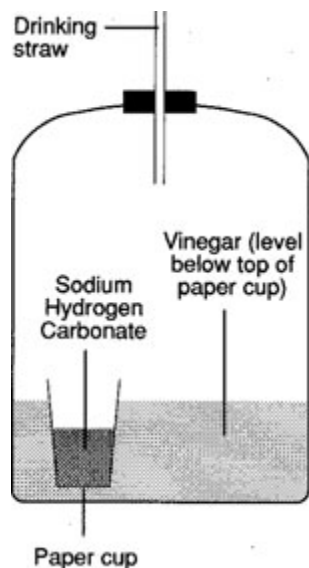
Trialled with a group of mixed ability second years, students were not given washing powder, just liquid detergent, to reduce variables. 500 cm³ measuring cylinders were fine for most students, but one or two needed to use the litre measuring cylinders. (It might be possible to use 500 cm³ beakers but they would really be too wide.) The foam makes it very difficult to read the calibrations on the measuring cylinder – colouring the mixture might help. Students were good at keeping a record of the amounts they used – which has to be quoted for their 'best' result to count. The greatest volume of foam was 800 cm³.

- **NB** Conkers make wonderful foam! Boil conkers up with water: peel conkers, mash them up, put in 250 cm³ beaker a third full of water. Boil for 5/10 minutes. DECANT SOLUTION. To make the froth: add sodium hydrogencarbonate (approximately a dessert spoon) and aluminium sulfate (sufficient acidity).

- Frothing agent obtained is the same as that found in shaving foams and fire extinguishers (a C₁₀ alcohol).

Extension work

Students could go on to design a 'foam launcher', and make a fire extinguisher that operates. They will need to consider the technical problem of delivering the foam to put out fire.



- Name some other examples of foams and their useful applications, eg shaving and whipped cream.

Credits

© Royal Society of Chemistry

Health & safety checked May 2018

Page last updated October 2018